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(54) Abstract Title
Vehicle parking brake

(57) An electrically controlled vehicle parking brake 22 is operated by a control unit 28 in response to inputs from a strain gauge 34 mounted on a suspension arm 20 for measuring braking torque, a parking brake on/off switch 30, a gear select switch and an engine control unit 32. The control unit 28 releases the parking brake 22, following operation of the switch 30, when the braking torque falls to a predetermined level i.e.substantially zero e.g.due to an increase in the drive torque when the vehicle is being driven uphill. Unit 28 also provides an input to unit 32 so as to control the drive torque in response to the braking torque during parking brake release. For a fully automatic parking brake operation, switch 30 is omitted and control unit 28 additionally receives vehicle speed sensor signals so as to apply the parking brake whenever the vehicle speed falls to a predetermined level e.g.zero.

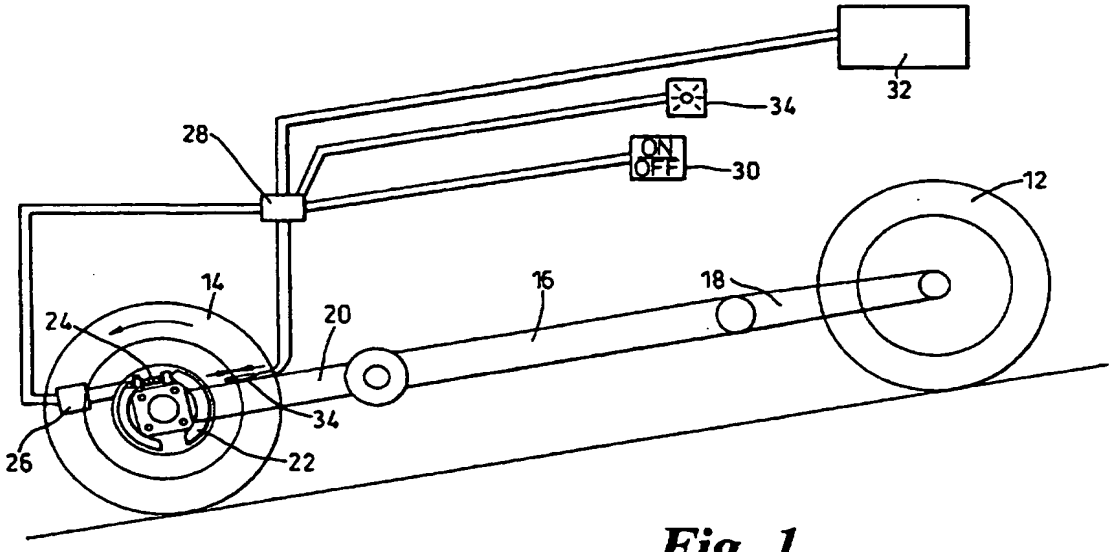

Fig. 1

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

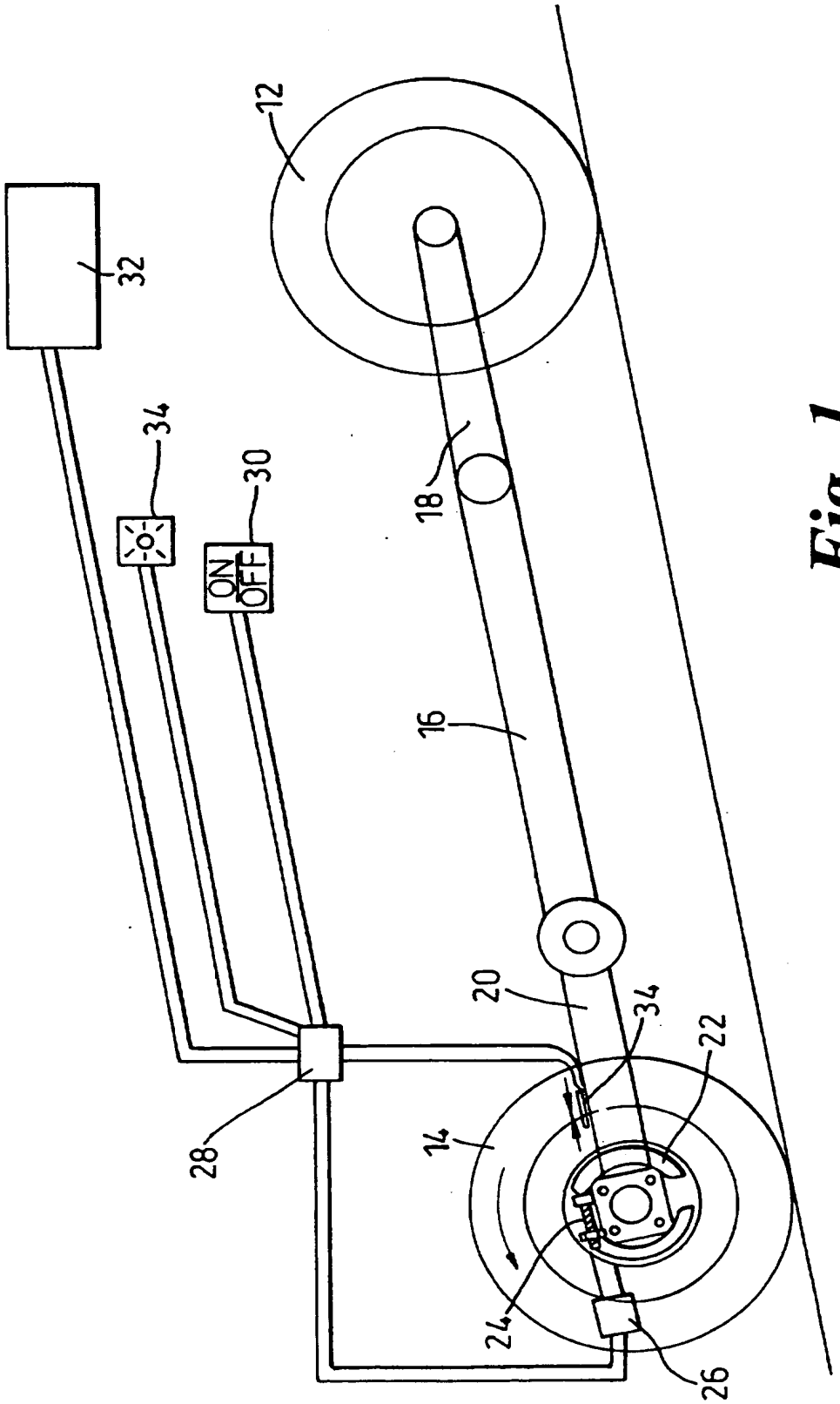

Fig. 1

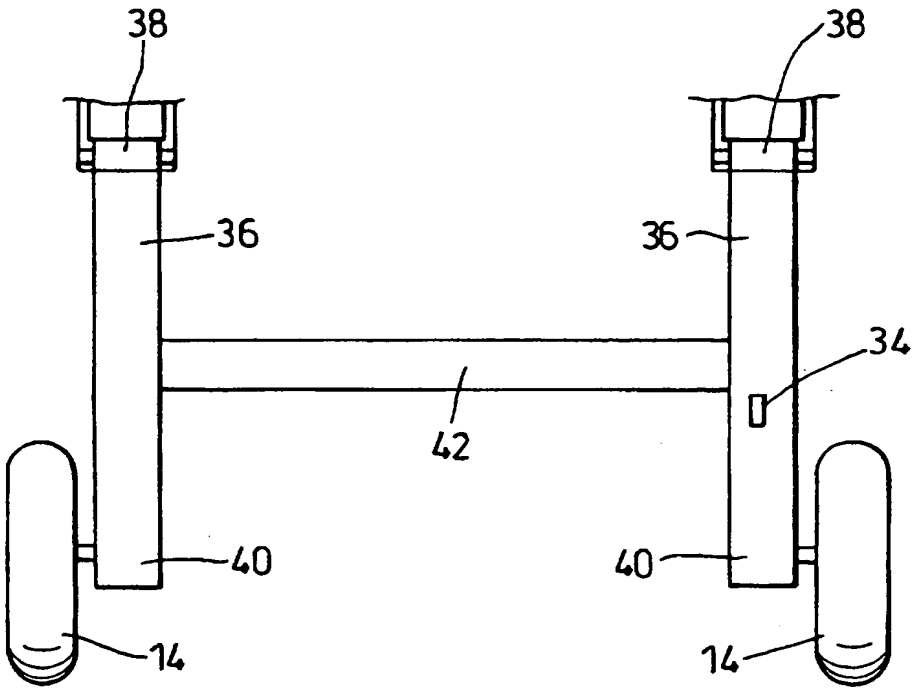

Fig. 2

Vehicle Parking Brakes

The present invention relates to vehicle parking brakes, and in particular to electrically operated parking brakes.

Parking brake systems are currently known in which the parking brakes are actuated electrically. The parking brake is generally engaged or released in response to operation of a simple switch by the driver. However such systems suffer from a lack of feed-back to the driver as to what state the hand brake is in. This can cause particular problems if the driver is attempting a hill start.

Accordingly the present invention provides apparatus for controlling a vehicle parking brake the apparatus comprising actuation means for applying and releasing a parking brake, braking torque measuring means for measuring the amount of braking torque applied to at least one wheel of the vehicle by the parking brake, and control means arranged to monitor the braking torque and release the parking brake when the braking torque falls to a predetermined level

Preferably the apparatus further comprises driver input means, such as a manual switch, arranged to send a release signal to the parking brake control means, wherein the control means is arranged, on receipt of the

release signal to check said braking torque and to delay release of the parking brake until said braking torque falls to said predetermined value.

The control means is preferably arranged to control the driving torque applied to at least one wheel of the vehicle by a power train of the vehicle during release of the parking brake.

The present invention further provides apparatus for controlling a vehicle power train the apparatus comprising a source of driving torque for at least one wheel of the vehicle, braking means for applying a braking torque to at least one wheel of the vehicle, braking torque measuring means for measuring the amount of said braking torque, and control means arranged to control the level of said driving torque during release of the braking means in response to the measured braking torque.

Preferably the control means is arranged to limit said driving torque during release of the parking brake to maintain it below a maximum level during release of the parking brake.

Preferably the control means is arranged to maintain the driving torque above a predetermined minimum level during release of the parking brake to ensure that the power train is producing sufficient torque to drive the vehicle on release of the braking means.

Preferably the torque measuring means is arranged to operate by measuring the strain in a part of a suspension system to which the wheel or wheels is or are attached. Alternatively it could be arranged to measure the load on the non-rotating part of the brake produced by the rotating part, i.e. the calliper of a disk brake or the back plate supporting the shoes of a drum brake.

The present invention further provides apparatus for measuring the torque applied to a vehicle wheel, the apparatus comprising strain measuring means arranged to measure the strain in a part of a suspension system to which the wheel or wheels is or are attached.

Said part of said suspension system may comprise a suspension arm having one end pivotably connected to a sprung part of the vehicle and the other end connected to said wheel or one of said wheels. However, it will be appreciated that many parts of a suspension system will experience a strain if a braking, or driving, torque is applied to the wheel it carries, and therefore this means of measurement is applicable to most suspension systems.

The present invention still further provides a control system for a vehicle parking brake comprising control means for controlling the application of a parking brake, and vehicle speed measuring means,

wherein the control means is arranged to apply the parking brake automatically when the vehicle speed falls to a predetermined value.

Preferably said predetermined value is zero.

Preferred embodiments of the present invention will now be described by way of example only with reference to the accompanying drawings in which:

Figure 1 is a schematic diagram of a vehicle including a braking system according to the invention,

Figure 2 shows part of the suspension of the vehicle of Figure 1.

A vehicle 10 has a pair of front wheels 12 and a pair of rear wheels 14 connected to a vehicle body 16 by means of front 18 and rear 20 suspensions respectively. The vehicle includes a braking system including service brakes (not shown) and parking brakes comprising a pair of drum brakes 22 operating on the rear wheels. The parking brakes 22 are each actuated electrically by a screw-type actuator 24 driven by an electric motor 26 under the control of a parking brake control unit 28. The parking brake control unit 28 receives inputs from a dash-mounted switch 30, the vehicle engine control unit 32, and a strain gauge 34 mounted on the rear suspension 20. It

sends outputs to the motors 26, the engine control unit 28 and an indicator light 34 also mounted on the dash.

Referring to Figure 2, the rear suspension 20 is a torsion beam suspension comprising a pair of longitudinal suspension arms 36 pivotably attached to the vehicle body at the front end 38 and having the rear wheels 14 mounted at the rear end 40, and a torsion beam 42 extending transversely of the vehicle between the longitudinal arms 36 and joined to them at points between the front and rear ends. The strain gauge 34 is mounted on one of the longitudinal arms 36.

It will be appreciated that if the parking brake 22 is applied and the vehicle is resting on a hill as shown, the weight of the vehicle will tend to cause it to roll down the hill turning the rear wheels backwards, i.e. anti-clockwise as shown in Figure 2. Therefore the parking brake applies a torque in the opposite direction, i.e. in the forward direction of the wheels, to keep the vehicle stationary. This torque is reacted back into the suspension arms 36 at their rear ends 40. This puts a strain on the suspension arms tending to cause them to bow upwards in the centre, and this strain can be measured by the strain gauge 34. The signal from the strain gauge can therefore be used as a measure of the braking torque applied to the rear wheels 14 by the parking brakes 22.

Assuming that the vehicle is parked and the parking brakes 22 are applied, if the driver operates the control switch 30 to request release of the parking brake, the parking brake control unit 28 checks the braking torque using the signal from the strain gauge. If it is below a predetermined level, i.e. substantially zero, then the parking brake is released immediately by operating the actuators 24. If, however, the brakes are a applying a braking torque, the parking brake is not immediately released and the control unit 28 enters a hill start routine.

In the hill start routine the control unit 28 compares the direction of the braking torque with the state of the vehicle transmission using the gear select switch to determine whether a drive gear has been selected by the driver, and if so, whether it is forward or reverse. If this check determines that the transmission is arranged to drive the vehicle down the hill, then the parking brake is released immediately, but at a rate which decreases with increasing initial braking torque so as to avoid sudden release of the brakes on a steep hill. If, on the other hand, it determines that the transmission is arranged so as to drive the vehicle up the hill, it does not release the parking brake 22 immediately, but monitors the torque. As the driver increases the drive torque to the wheels from the vehicle power train by depressing the accelerator pedal, and releasing the clutch if the vehicle has a manual transmission, the braking torque will decrease as the drive torque takes over from it in preventing the vehicle from descending the hill.

When the measured braking torque falls to a predetermined level, which could be zero, the control unit 28 operates the parking brake actuators 24 so as to release the parking brake. In this way the parking brake is only released when the driving torque is sufficient to drive the vehicle up the hill.

Because the parking brake control unit provides an input to the engine control unit 32 it can control the driving torque to the wheels in response to the measured braking torque while the parking brakes are being released. In its simplest form this control amounts to limiting the driving torque to a predetermined level if a braking torque of more than a predetermined level is present, or during the release of the brakes. In a more sophisticated version the control unit is arranged, when operating in the hill start mode, to control the driving torque and the braking pressure simultaneously. This can be done by maintaining at least a minimum driving torque, the value of which is dependent on the gradient of the hill as measured by measuring the initial braking torque, during release of the brakes so as to ensure that there is always enough driving torque to drive the vehicle up the hill so that the engine will not stall. Alternatively it can be done by increasing the driving torque and decreasing the braking pressure so as to transfer the load smoothly from the brakes to the power train in a controlled manner, the rate of which is arranged to vary with the initial braking torque, i.e. with the gradient of the hill. When the load is fully transferred to the power

train, the driving torque is then maintained at a constant level sufficient to keep the vehicle stationary until the driver requests a higher torque to start the vehicle moving up the hill.

In a second embodiment of the invention, the switch 30 is deleted and the control unit 28 is arranged so as to operate the parking brake in a fully automatic manner, the only additional input needed being a speed sensor, for measuring the speed of the vehicle, for example by measuring the speed of rotation of the wheels 12, 14. The control unit is arranged to apply the parking brake whenever the vehicle speed falls to a predetermined level, which could be zero. Thereafter the control unit monitors the gear selection switch, the engine torque as indicated by the engine control unit 32, and the braking torque applied to the rear wheels 14 as indicated by the strain gauge 34. If the braking torque falls to zero when the vehicle is in gear, i.e. in either a forward or reverse gear, and the engine is providing more than a predetermined level of torque indicating that it is not at idle but is applying a driving torque to the wheels, the parking brake is released. This will allow controlled start when the driver is starting from rest in an uphill direction, which can be determined from the gear selected and the initial direction of the measured braking torque. If these inputs detect that the driver is starting in a downhill direction, then the parking brake can be released in a controlled manner as soon as a positive driving torque is produced by the power train in the downhill direction.

It will be appreciated that this invention could also be applied using a hydraulic traction control system, since these systems include a source of braking torque which can be applied independently of the driver's inputs. However, in this case the hydraulic application of the brakes cannot be maintained while the vehicle is parked and the engine turned off, and a further mechanism for mechanically locking the parking brakes on would be required.

CLAIMS

1. Apparatus for controlling a vehicle parking brake the apparatus comprising actuation means for applying and releasing a parking brake, braking torque measuring means for measuring the amount of braking torque applied to at least one wheel of the vehicle by the parking brake, and control means arranged to monitor the braking torque and release the parking brake when the braking torque falls to a predetermined level.

2. Apparatus according to claim 1 further comprising driver input means arranged to send a release signal to the parking brake control means, wherein the control means is arranged, on receipt of the release signal to check said braking torque and to delay release of the parking brake until said braking torque falls to said predetermined value.

3. Apparatus according to claim 1 or claim 2 wherein said predetermined value is zero.

4. Apparatus according to any foregoing claim wherein the control means is arranged to control the driving torque applied to at least one wheel of the vehicle by a power train of the vehicle during release of the parking brake.

5. Apparatus for controlling a vehicle power train the apparatus comprising a source of driving torque for at least one wheel of the vehicle, braking means for applying a braking torque to at least one wheel of the vehicle, braking torque measuring means for measuring the amount of said braking torque, and control means arranged to control the level of said driving torque during release of the braking means in response to the measured braking torque.

6. Apparatus according to claim 4 or claim 5 wherein the control means is arranged to limit said driving torque during release of the parking brake to maintain it below a maximum level during release of the parking brake.

7. Apparatus according to any one of claims 4 to 6 wherein the control means is arranged to maintain the driving torque above a predetermined minimum level during release of the parking brake to ensure that the power train is producing sufficient torque to drive the vehicle on release of the braking means.

8. Apparatus according to any foregoing claim wherein the torque measuring means is arranged to operate by measuring the strain in a part of a suspension system to which the wheel or wheels is or are attached.

9. Apparatus for measuring the torque applied to a vehicle wheel, the apparatus comprising strain measuring means arranged to measure the strain in a part of a suspension system to which the wheel or wheels is or are attached.

10. Apparatus according to claim 8 or claim 9 wherein said part of said suspension system comprises a suspension arm having one end pivotably connected to a sprung part of the vehicle and the other end connected to said wheel or one of said wheels.

11. Apparatus according to claim 10 wherein the suspension arm extends in a generally longitudinal direction of the vehicle.

12. Apparatus according to any foregoing claim further comprising vehicle speed measuring means, wherein the control means is arranged to apply the parking brake automatically when the vehicle speed falls to a predetermined value.

13. Apparatus according to claim 12 wherein said predetermined speed is zero.

14. A control system for a vehicle parking brake comprising control means for controlling the application of a parking brake, and vehicle speed

measuring means, wherein the control means is arranged to apply the parking brake automatically when the vehicle speed falls to a predetermined value.

15. Apparatus for controlling a vehicle power train substantially as hereinbefore described with reference to the accompanying drawings.

16. Apparatus for controlling a vehicle parking brake substantially as hereinbefore described with reference to the accompanying drawings.

17. Apparatus for measuring the torque applied to a vehicle wheel substantially as hereinbefore described with reference to the accompanying drawings.

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Application No: GB 9822994.1 **Examiner:** Peter Squire
Claims searched: 1-4 & claims dependent thereon **Date of search:** 30 April 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): F2F FA FC G3N NGCA5

Int Cl (Ed.6): B60T 7/12 B60K 41/20, 28

Other: Online:WPI,EPODOC,JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	EP 0389205 A1	(Lucas) see whole document	1, 3, 8, 10-13
X	US 5484044	(Bursteinas et al) see e.g.col.7 lines 26-29 & col.8 lines 15-62	1-3
X	US 4666021	(Messersmith) see e.g.col.4 lines 47-63	1

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

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Application No: GB 9822994.1
Claims searched: 5-8

Examiner: Peter Squire
Date of search: 3 August 1999

Patents Act 1977
Further Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): F2D DA DCG(E) F2L LG F2F FA

Int Cl (Ed.6): B60K 41/20, 28

Other: Online:WPI,EPODOC,JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 0710180	(Vivian)	
A	US 4635767	(Crane)	

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&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.